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PHYSICS.—*The compressibility of diamond.*[1] L. H. ADAMS, Geophysical Laboratory, Carnegie Institution of Washington.

Many of the properties of that remarkable form of carbon, the diamond, are known, but its compressibility has never been measured. The commercial value of a quantity of diamonds sufficient for such a determination is so great that the opportunity for making the determination would seldom present itself. It is not necessary for this purpose, however, that the material be in one piece or even in large fragments although, contrary to what is commonly believed, no apprehension need be felt in subjecting diamonds or any other homogeneous material to the enormous pressures required.[2]

It was the writer's good fortune to have at his disposal about 80 grams of diamond chips obtained through Dr. F. E. Wright, of this Laboratory, from S. L. Van Wezel, Inc., of New York City.[3] The material was in the form of clear, colorless fragments of various sizes up to one or two millimeters in their largest dimension. A small amount of metallic impurity was found to be present and was removed by treatment with hot nitric acid. After being washed with water and dried in the oven, a fraction consisting of about 30 grams of the coarser fragments was separated from the remainder and was used for the measurement of the compressibility.

The method used has been described in a former publication[4] from this Laboratory. Briefly, it is as follows: The material to be investigated is surrounded by kerosene and placed in a cylindrical, heavy-walled, steel bomb, one end of which is closed while in the other end is fitted a piston with a suitable packing. Pressure is applied

[1] Received January 8, 1921.

[2] As long, of course, as the pressure is strictly hydrostatic, that is, uniform in all directions.

[3] Our thanks are due to this firm and especially to the President, Mr. M. S. Van Wezel, for their courtesy in lending this material.

[4] L. H. ADAMS and E. D. WILLIAMSON, Journ. Amer. Chem. Soc. 41: 12–42. 1919.

by forcing the piston into the bomb by means of a powerful hydraulic press. In order to determine the compressibility it is necessary to measure the pressure and the decrease in volume. The pressure is measured by means of a small coil of "therlo" wire the resistance of which changes with pressure according to a known relation; and the volume-decrease is determined by the movement of the piston, which is measured with a dial micrometer. Pressures were read to 1 megabar and piston displacements to 0.001 mm. As a means of correcting for the compressibility of the kerosene, an exactly similar series of measurements is carried out with some other substance of known compressibility.

The diamonds were placed in a thin-walled steel capsule, and the comparison body was a Bessemer steel cylinder the volume of which was equal to the volume of the diamonds plus the volume of metal in the capsule. In order to remove any air bubbles which might cling to the diamond fragments, the material, having been placed in the capsule, was covered with kerosene and the whole evacuated.

With the apparatus used the most accurate measurements are obtained in the range from 4,000 to 10,000 megabars.[5] Accordingly, it seemed best to make several series of readings within this range of pressure. Readings were taken at 4,000, 6,000, 8,000 and 10,000 megabars. Three separate runs were made with the diamond and two with the steel, but the first series with the diamond was subject to slight irregularities due to trouble with the electrical connections and was therefore neglected in the final calculations. The method for calculating the results and for making the various corrections is described in detail in the paper already referred to.

Various ways of combining the data of the two series for steel and the two series for diamond led to substantially the same result. If the mean of the former be compared with the mean of the latter, the relative decrease in volume, $\frac{\Delta v}{v_o}$, is found to be as shown in table 1.

TABLE 1

DECREASE OF VOLUME OF DIAMOND UNDER PRESSURE

Pressure megabars p.	Volume decrease $\frac{\Delta v}{v_o} \times 10^3$.	$\frac{\Delta v}{v_o} \times 10^3$. Calc. from equation (1).	Diff.
4000	0	0.05	−0.05
6000	1.01	0.93	+0.08
8000	1.81	1.82	−0.01
10000	2.68	2.70	+0.02

[5] 1 megabar = 0.987 atmosphere.

In table 1 the second column shows the "observed" relative decrease in volume corresponding to the pressures given in the first column. The arbitrary zero with reference to the volume change was at 4000 megabars.

The decrease in volume was assumed to be a linear function of the pressure, that is,

$$\frac{\Delta v}{v_0} \times 10^3 = a + b\,(p - p_0) \times 10^{-3}, \qquad (1)$$

and by the method of least squares the values of the constants a and b were calculated from the data in table 1. The value found for b was 0.442, which, multiplied by 10^{-6}, is the difference between β, the compressibility of diamond, and β', that of steel. That is, $\beta' - \beta = 0.44 \times 10^{-6}$. If the compressibility of steel[6] be taken as 0.60×10^{-6} the compressibility of diamond is

$$\beta = 0.16 \times 10^{-6} \text{ per megabar.}$$

This value is estimated to be correct within $\pm 0.02 \times 10^{-6}$.

From this result it is evident that the compressibility of diamond is remarkably low; indeed, of all substances whose elastic behavior is known, diamond is by far the most incompressible. Its nearest competitor, tungsten, is nearly twice as compressible ($\beta = 0.27 \times 10^{-6}$), and the majority of solids decrease their volume more than ten times as much for a given increment of pressure. If a diamond were buried 100 miles below the surface of the earth the pressure due to the superincumbent rock—a higher pressure than has ever been attained in the laboratory—would decrease the volume only about three-fourths of one per cent.

It is noteworthy that the other modification of carbon, graphite, is much more compressible, the value of β, according to Richards,[7] being 3.0×10^{-6}.

Relation of compressibility to other properties.—Einstein[8] has derived the following equation, involving the compressibility β

[6] Compare P. W. BRIDGMAN, Proc. Amer. Acad. 47: 366. 1911. E. GRÜNEISEN, Ann. Phys. (4) 33: 1262. 1910.

[7] T. W. RICHARDS, Journ. Amer. Chem. Soc. 37: 1646. 1915.

[8] A. EINSTEIN, Ann. Phys. (4) 34: 170. 1911. The specific heat per gram-atom, C_v of any monatomic solid, according to Einstein, is a universal function of ν/T, thus:

$$C_v = 3R \frac{e^{h\nu/kT} \cdot (h\nu/kT)^2}{(e^{h\nu/kT} - 1)^2}$$

R, h and k being universal constants.

(in absolute units), the atomic weight A, the density ρ, and the vibration frequency ν of the atoms:

$$\nu = 3.3 \times 10^{7} A^{-\frac{1}{3}} \rho^{-\frac{1}{6}} \beta^{-\frac{1}{2}} \qquad (2)$$

Lindemann,[9] on the other hand, calculates ν from the equation:

$$\nu = 3.1 \times 10^{12} A^{-\frac{1}{3}} \rho^{\frac{1}{3}} T_m^{\frac{1}{2}} \qquad (3)$$

in which T_m is the melting point on the absolute scale. Eliminating ν from these two equations, and multiplying by 10^6 in order to change the units of β from cm²/dyne to cm²/megadyne, we have:

$$\beta = 1.13 \times 10^{-4} \frac{A}{\rho T_m}. \qquad (4)$$

This equation closely resembles the empirical equation used by Richards,[10] namely, $\beta = 2.1 \times 10^{-4} \frac{A}{\rho^{1.25} (T_m - 50)}$, and yields for many elements values of β which are in fair accord with the observed values. The melting point of diamond is not known, but assuming that it is 4000°, and taking ρ as 3.51, the value of β calculated from equation (4) is 0.10×10^{-6}. As calculated from Richards' formula, the value is 0.13×10^{-6}.

Another equation may be obtained from Grüneisen's formula:[11]

$$\nu = 2.9 + 10^{11} \left(\frac{c_v}{\alpha}\right)^{\frac{1}{2}} A^{-\frac{1}{3}} \rho^{\frac{1}{6}} \qquad (5)$$

in which c_v is the specific heat per gram, and α is the cubical expansion coefficient. Eliminating ν from equations (2) and (5) and multiplying by 10^6 as before, we have

$$\beta = 1.29 \times 10^{-2} \frac{\alpha}{c_v \rho}. \qquad (6)$$

This equation clearly illustrates the fact that low compressibility tends to be accompanied by low thermal expansibility. In using equation (5) or (6) for numerical calculation, however, for the ratio $\frac{\alpha}{c_v}$ must be taken its *limiting value* as the temperature is decreased. It may be noted, nevertheless, that if the values of c_v and α for diamond at 25° C. ($c_v = 0.12$ cal. per g.; $\alpha = 3.5 \times 10^{-6}$) be substituted in equation (6), β is found to be 0.11×10^{-6}.

[9] F. A. LINDEMANN, Phys. Zeitschr. 11: 609. 1911.

[10] Op. cit., p. 1653. See also W. D. HARKINS and R. E. HALL, Journ. Amer. Chem. Soc. 8: 209. 1916.

[11] E. GRÜNEISEN, Ann. Phys. (4) 39: 293. 1912.

Another useful relation involving the compressibility is that given by Debye:[12]

$$\theta = \frac{h\nu_m}{k} = \frac{35.74 \times 10^{-4}}{A^{1/3}\,\rho^{1/6}\,\beta^{1/2}} \cdot \frac{1}{\phi^{1/3}} \qquad (7)$$

In this equation β is in absolute units, and ϕ is a function of σ, Poisson's ratio,[13] thus:

$$\phi = 2\left(\frac{2}{3}\cdot\frac{1+\sigma}{1-2\sigma}\right)^{3/2} + \left(\frac{1+\sigma}{3(1-\sigma)}\right)^{3/2}$$

Rearranging equation (7), substituting Debye's values for h and k, and expressing β in cm.^{2}/megadyne, we have:

$$\beta = 5.5 \times 10^{21}\,\nu_m^{-2}\,A^{-2/3}\,\rho^{-1/3}\,\phi^{-2/3} \qquad (8)$$

The value of ν_m for any element can be calculated from equation (7) provided that the specific heat is known at one or more suitable temperatures; and ϕ can be calculated when σ, Poisson's ratio, is known. Equation (8), then, can be used to calculate the compressibility of any element for which C_v and σ have been measured. For several elements for which these quantities are known the compressibilities have been calculated by equation (8) with the results shown in table 2.

TABLE 2

CALCULATION OF COMPRESSIBILITY FROM SPECIFIC HEAT AND POISSON'S RATIO

Substance.	Max. atomic frequency $\nu_m \times 10^{12}$.	At. wt. A.	Density ρ.	Poisson's ratio σ.	Compressibility calc. from equation (8) $\beta \times 10^6$.	$\beta \times 10^6$ observed.
Aluminum.....	8.2	27.1	2.7	0.34	1.42	1.32
Copper.....	6.4	63.6	8.9	0.35	0.83	0.75
Silver.....	4.4	107.9	10.5	0.38	0.92	0.97
Lead.....	2.0	207.2	11.3	[0.45]	[1.1]	2.2
Diamond.....	39.2	12.0	3.5	(0.25)	0.16	0.16

The values for ν_m are taken from Debye and those for σ are as given by Grüneisen.[14] Poisson's ratio for diamond has not been measured,

[12] P. DEBYE, Ann. Phys. (4) **39**: 816. 1912. Debye considers that the atoms in a solid are vibrating, not with a single frequency, but with a number of different frequencies, and that the specific heat is a universal function of $\frac{\nu_m}{T}$, ν_m being the maximum frequency. His equation is:

$$C_v = 3R\left\{\frac{12}{x^3}\int_0^x \frac{q^3 dq}{e^q - 1} - \frac{3x}{e^x - 1}\right\}$$

in which $x = \frac{h\nu_m}{kT} = \frac{\theta}{T}$, and q is an integration variable.

[13] Strictly speaking, Poisson's ratio has no meaning except with reference to an isotropic or pseudo-isotropic substance.

[14] E. GRÜNEISEN, Ann. Phys. (4) **25**: 847. 1908.

but in accordance with the well-known fact that, in general, σ for hard and highly incompressible substances is approximately 0.25, it has been assumed to have this value. The agreement between β calculated and β observed is satisfactory except for lead. Poisson's ratio, however, is a difficult property to measure accurately, and the large discrepancy in the case of lead, as well as the smaller discrepancies for the other metals may, not unreasonably, be ascribed to an error in the values of σ. For example, if σ for lead were 0.40 instead of 0.45 as given by Grüneisen, equation (8) would yield a value of β almost exactly equal to the observed value.

Since a small change in σ leads to a large change in β, or, conversely, since a given change in β corresponds to a much smaller variation in σ, this equation may be used to calculate with high precision the value of the important elastic constant, σ, for all those elements for which the compressibility and specific heat are known. Thus, granting the validity of the reasoning by which Debye arrived at his formula—the remarkable success of Debye's specific heat formula in accurately representing the variation of specific heat with temperature would seem to substantiate the soundness of his theory—we may state with considerable confidence that Poisson's ratio for diamond is not far from 0.25.

In the course of the measurement of the compressibility of diamond the density of the fragments was determined by the pyknometer method and found to be 3.513 at 25°. This is in good agreement with the value 3.514 at 18° obtained by Cohen and Olie.[15]

Summary.—The cubic compressibility $\frac{1}{v_0} \cdot \frac{dv}{dp}$ of clear, colorless diamond of density 3.513 was measured by comparison with soft steel. Assuming the compressibility of steel to be 0.60×10^{-6} per megabar, the compressibility of diamond is

$$0.16 \times 10^{-6} \text{ per megabar.}$$

This is the lowest compressibility of any known substance.

From a consideration of various formulas expressing the relations connecting compressibility with other physical properties, it appears that the low compressibility of diamond is intimately related to its high melting point, its low expansion coefficient, and its high atomic frequency.

Very accurate values of Poisson's ratio for the various elements might be obtained by Debye's equation if the compressibility and specific heat were previously determined.

[15] E. COHEN and J. OLIE, JR., Zeitschr. Phys. Chem. 71: 391. 1910.

ELECTRICAL ENGINEERING.—*Oscillograph measurements of the instantaneous values of current and voltage in the battery circuit of automobiles.* G. W. VINAL and C. L. SNYDER, Bureau of Standards.[1]

Performance curves showing the instantaneous demands made upon automobile starting and lighting batteries when cranking the engines have been obtained recently at the Bureau of Standards. These curves were made while preparing specifications for this type of battery for the Motor Transport Division of the War Department. In the course of these experiments additional information was obtained with respect to the operation of the starter system and the engine itself.

In order to measure the rapidly fluctuating values of current and voltage a 3-element oscillograph was used. The ordinary film drum was replaced, however, by a camera of special construction. Time was recorded by one element while the current and the battery voltage were measured by the two remaining elements. The oscillograph records show the instantaneous values of current and voltage which cannot be obtained with the ordinary indicating instruments.

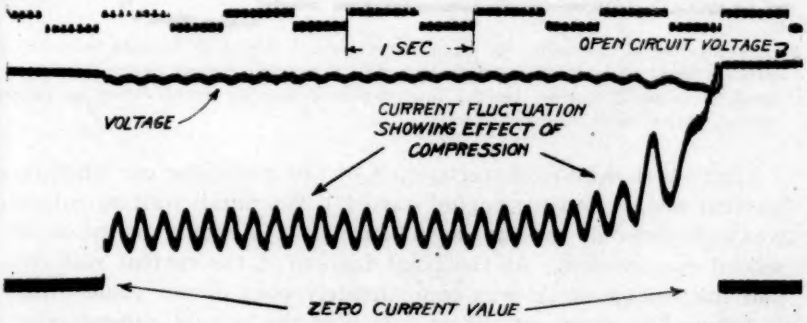

Fig. 1.—Fluctuations of current and voltage in battery circuit when starter cranks the engine. Initial value of current 125 amperes. Four cylinder car 12-volt single unit system. Time scale in half seconds at top of record.

A series of measurements under various conditions of operation was made upon a number of cars of different makes. The records for the various cars show different characteristics which are typical of the design and condition of the engine and starter system. All of the

[1] Published by permission of the Director, Bureau of Standards. Received December 22, 1920. The complete paper will be published as Technological Paper No. 186 of the Bureau of Standards.

cars were in ordinary running order when the measurements were made.

It is possible to show only two of the records in the present paper. These have been chosen to illustrate the general character of the curves which were obtained from a well-known 4-cylinder car equipped with a 12-volt single unit starting system. Figure 1 shows the fluctuations of current and voltage when the starter was in operation. The initial starting current was about 125 amperes, but decreased rapidly. The pulsating character of the current is due to the compression in the successive cylinders. The minimum values of the voltage correspond with the maximum values of the current. The time scale in half seconds is shown at the top of the record.

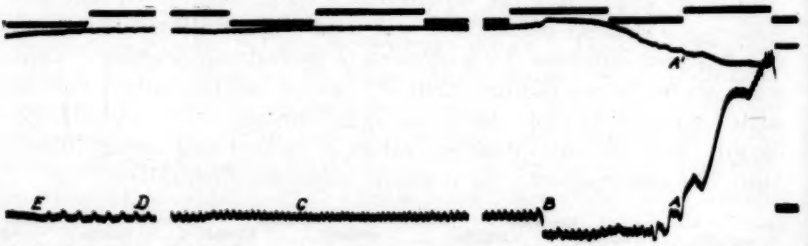

Fig. 2.—Starting of the engine, on second compression. *A* and *A'* indicate operation of reverse current relay; *B*, release of starter pedal; *C*, charging current, engine speeding; *D*, speed decreased; *E*, ignition cut-off. Interruptions in charging current caused by ignition system. Same car as for Fig. 1.

Figure 2 shows the characteristics of this particular car when the ignition was on and the engine started. The initial starting current was approximately the same as in figure 1. The engine started on the second compression. At the point marked *A* the current was zero and the voltage at *A'* was approximately open circuit value. This is believed to represent the operation of the reverse current relay. An instant later the battery began to charge at a high rate—as indicated by the current curve falling below the indices and the voltage curve rising abruptly to a value in excess of the open circuit voltage. At *B* the starter pedal was released and the current returned to the normal charging value. A corresponding drop in voltage occurred at the same time. The engine was racing at *C*, slowed down at *D*, and the ignition was cut off at *E*. The interruptions seen in the charging current are due to the current flowing through the ignition coil which is operated by the distributor.

Analysis of the curves has suggested the possibility of using this method for the study of problems relating to the design of engines and starter systems. The method provides an exact means of measuring the speed of rotation and of detecting small changes in speed from one revolution to another. Additional experiments to show the effect of temperature compression, lubrication and throttle opening were made also. These will be described in the complete paper.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. The abstracts should conform in length and general style to those appearing in this issue.

BOTANY.—*The influence of cold in stimulating the growth of plants.* F. V. COVILLE. Journ. Agr. Res. **20:** 151–160. Pls. 20–35. 1920.

The dormancy of trees and shrubs begins before the advent of cold weather. Cold weather is not necessary to bring about dormancy. It is necessary to bring about renewed growth in the spring. If not subjected to cold, dormant plants will not start growth in the spring. Even on the same plant a branch which has been chilled will start growth under proper conditions while an adjoining branch which has not been subjected to chilling will remain dormant. The best temperature for chilling is 32° to 40° F. It may be applied in either light or darkness.

During chilling the reserve food stored in the form of starch is changed to sugar. Until this change has taken place the plant is unable to use the stored food for renewed growth. H. V. HARLAN.

BOTANY.—*Revisions of North American grasses.* A. S. HITCHCOCK and AGNES CHASE. Contr. U. S. Nat. Herb. **22:** 1–77. Pls. 1–24, figs. 1–20. 1920.

This number of the Contributions consists of four independent papers: (1) The North American species of Ichnanthus, by Hitchcock; (2) The North American Species of Lasiacis, by Hitchcock; (3) The North American Species of Brachiaria, by Chase; (4) The North American Species of Cenchrus, by Chase. *Ichnanthus* is a tropical genus allied to *Panicum*. *Lasiacis* is a tropical genus of woody grasses, also allied to *Panicum*, one species of which extends into southern Florida. Of the 6 American species of *Brachiaria* two extend into Texas. The species of *Cenchrus* are usually known as sandburs. Eight of the 13 species described are found in the United States. A. S. H.

BOTANY.—*Revisions of North American grasses.* A. S. HITCHCOCK. Contr. U. S. Nat. Herb. **22:** 115–208. Pls. 25–32, figs. 21–62. 1920.

This number of the Contributions includes four independent papers on the North American species of the genera *Isachne*, *Oplismenus*, *Echinochloa*, and *Chaetochloa*. *Isachne* and *Oplismenus* are tropical genera, one species of the latter extending into our southern states. The species of *Echinochloa* are widely distributed, some of them being common weeds. One of the forms of *E. crusgalli*, barnyard grass, is cultivated under the name of Japanese barnyard millet. The species of *Chaetochloa* (*Setaria*) are also widely distributed. Some species are common weeds, such as *C. lutescens*, yellow foxtail, and *C. viridis*, green foxtail. One species, *C. italica*, is the commonly cultivated millet, or foxtail millet, one form of which is called Hungarian grass. One species is grown in greenhouses as an ornamental, the broad plaited blades giving it the name of palm grass. Twenty-six species are described and figured. A. S. H.

BOTANY.—*Heritable characters of maize. I. Lineate leaves.* G. N. COLLINS and J. H. KEMPTON. Journ. Heredity **11**: 3–6. January, 1920.

This paper is the first of a series in which it is planned to record variations in maize that prove to be inherited. "Lineate leaves," the character here described, consist of a very fine, white striping of the upper leaf blades. The progenies of self-pollinated lineate plants and crosses between lineate and normal plants indicate that the character is a Mendelian monohybrid. The character is variable in expression, however, and 2 progenies out of 14 showed significant departures from monohybrid ratios. G. N. C.

ENTOMOLOGY.—*A revision of the nearctic termites.* NATHAN BANKS, with *Notes on biology and geographic distribution.* THOMAS E. SNYDER. U. S. Nat. Mus. Bull. **108**. Pp. 228, pls. 35, figs. 70. 1920.

This paper is divided into two distinct parts. The first deals with the taxonomy of the termites, or white ants, of the Nearctic Region; while the second part contains a comprehensive summary, supplemented by original observations accumulated by the junior author, of the habits and distribution of these interesting economic insects. In the part dealing with the taxonomy each species and genus is characterized in detail and synoptic keys to all the forms are given. Seventeen new species and one new variety are described, thus almost doubling the number of forms previously known. That portion of the bulletin which deals with the biology gives first a summary of the habits of these insects and discusses the nesting, feeding swarming, mating, metamorphosis, castes, parasites, economic importance, control, etc., and then gives a complete account of the available information concerning each species.

This paper is the most important work on our white ants and no worker interested in these insects can be without it. S. A. ROHWER.

ENTOMOLOGY.—*Black grain-stem sawfly of Europe in the United States.* A. B. GAHAN. U. S. Dept. Agr. Bull. **834**. Pp. 18, pls. 2. 1920.

The black grain-stem sawfly (*Trachelus tabidus* (Fabr.)), a European pest of wheat, rye and similar grains, has been known to occur in the United States since 1899, but only in the last few years has it attracted attention as a pest. This bulletin gives a history of the discovery of the insect in America, what is known of its distribution, habits, host-plants, synonymy, injury, suggestions for control, parasites and a practically complete list of available literature. The adult is figured in both sexes and distinguishing characters for the larva, separating it from allied species living in similar situations, are included. This pest mines the stems of grains and besides thus reducing the ability of the grain to head does its greatest damage by cutting the stems close to the ground prior to the time it goes into hibernation. The cutting of the stems causes the grain to fall and thus escape the harvester.

S. A. ROHWER.

ETHNOLOGY.—*Native cemeteries and forms of burial east of the Mississippi.* DAVID I. BUSHNELL, JR. Bur. Amer. Ethnol. Bull. **71**. Pp. 160, pls. 17, figs. 17. 1920.

The reports of early writers contain a great body of information regarding the burial rites and customs of our American Indians which are of particular importance to the archeologist, and in the present work Mr. Bushnell has brought together as much of the available material as possible applying to

the United States east of the Mississippi River. This is arranged under the headings of the several Indian stocks and an attempt has been made to correlate it with the results of modern explorations. J. R. SWANTON.

ETHNOLOGY.—*Alsea texts and myths.* LEO J. FRACHTENBERG. Bur. Amer. Ethnol. Bull. **67**. Pp. 304. 1920.

Alsea is a dialect of the Yakonan linguistic family, which formerly occupied a small portion of the Oregon coast southward of the Columbia River. So few Indians are now acquainted with it that the material contained in this volume is, in all probability, practically all that will ever be available for study. It consists of 24 native texts with English translations, five originally recorded by Dr. Livingston Farrand, now Director of the American Red Cross, and the remainder by Dr. Leo J. Frachtenberg, who also revised and edited the material collected by his predecessor. Four tales collected by Dr. Farrand in English, without native equivalents, are added, and the whole is followed by vocabularies in Alsea-English and English-Alsea and a list of formative elements. A brief introduction explains the various ways in which this series of texts was brought together and indicates the character of Alsea mythology and its position with reference to the mythologies of the neighboring peoples. J. R. SWANTON.

EVOLUTION.—*Kinetics of material transformations.* ALFRED J. LOTKA Proc. Amer. Acad. Arts and Sciences **55**: 137–153. 1920.

A discussion along very general lines of the differential equations relating to systems undergoing change of state, chemical, physical, or other. The method and conclusions cannot be readily set forth in a brief abstract. While the immediate application is chiefly in the field of physical chemistry, a very general mode of treatment has been adopted with a view to preparing the ground for the discussion of the broad problem of evolution. A. J. L.

EVOLUTION.—*Evolution and irreversibility.* ALFRED J. LOTKA. Science Progress **14**: 406–417. Figs. 5. 1920.

It has been pointed out by biologists that organic evolution is an irreversible process. Physicists also have spoken of the second law of thermodynamics broadly as the law of evolution. In organic systems irreversible processes are attended with a decrease in certain functions of the variables defining the state of the system. Stable equilibrium is characterized by the fact that these functions assume a minimum value.

In the case of organic systems in the process of evolution we have not, in general, such definite criteria for equilibrium, and the direction of the process, although undoubtedly perfectly definite, has hitherto never been formulated in precise terms. The paper here abstracted sets forth, for certain cases at any rate, a precise formulation of the direction of evolution and a criterion for the stability of equilibrium in the familiar form of a function which assumes a minimum value at the point of equilibrium.

A. J. L.

GEOLOGY.—*Iron-depositing bacteria and their geologic relations.* E. C. HARDER. U. S. Geol. Survey Prof. Paper **113**. Pp. 89, figs. 37. 1919.

Iron-depositing bacteria are abundant and widespread in soil and natural water. They occur not only in surface waters but have been found in underground waters, such as well waters and iron-bearing mine waters, to depths

of more than 300 feet. They also inhabit distributing pipes and intakes of city water systems where the water contains an appreciable percentage of iron, and at times they become obnoxious in such situations.

The best-known iron-depositing bacteria such as Crenothrix, Leptothrix, and Spirophyllum belong to the group of organisms known as thread bacteria. Many coccus and bacillus forms also are known, which have the power of precipitating ferric hydroxide or basic ferric salts from iron-bearing solutions. Some iron-depositing bacteria require iron compounds in solution for their life processes; others do not require iron compounds, but use them when present. Some require inorganic iron compounds; others organic iron compounds, and still others use both. Many of these organisms have been cultivated on artificial media.

The importance of iron-depositing bacteria in the formation of iron-ore deposits is problematical. They are known to form bog-ore deposits and have been found depositing limonite in openings at moderate depths. Most of the large sedimentary iron-ore beds, however, are known to have been deposited in salt or blackish water and iron-depositing bacteria have not been found up to the present in such situations. E. C. H.

GEOLOGY.—*The copper deposits of Ray and Miami, Arizona.* F. L. RANSOME. U. S. Geol. Survey Prof. Paper **115**. Pp. 192, pls. 54, figs. 29. 1919.

The Ray and Miami districts lie about 18 miles apart in central Arizona, in the belt of mountain ranges that borders the Arizona Pla eau along its southwestern edge. From the beginning of modern operations in 1907 to the end of 1918 these districts have yielded 1,098,409,607 pounds of copper and the three principal copper companies have declared dividends amounting to $67,592,552.

The rocks of the region comprise pre-Cambrian schist and granite overlain by Paleozoic sedimentary rocks and limestones which in turn are unconformably overlain by Cretaceous andesitic rocks. Above these in the stratigraphic column are lavas and fluviatile detrital deposits of Tertiary and Quaternary age. The principal intrusive rocks are diabase, probably of early Mesozic age, and granite, granodiorite, quartz diorite, and related porphyries, probably of early or middle Tertiary age.

The principal copper deposits are of the enriched disseminated type and their most valuable constituent is chalcocite. The tenor of the ore ranges from about 1.5 to 6 per cent and about 260,000,000 tons were estimated as available at the beginning of the present mining operations. The ore bodies are undulating, flat-lying masses of more or less indefinite horizontal outline and of varying thickness. In a very general way they are marginally situated with reference to intrusive masses of granite, granite porphyry, and quartz monzonite porphyry, but the ore occurs both in the pre-Cambrian schist and in the Tertiary intrusive rocks. By far the greater part of the ore is in schist. The ore bodies are the result of the operation of two general processes—upward or hypogene metallization as a consequence of the intrusion of granite or monzonite porphyries, and downward or supergene enrichment by percolating atmospheric water.

Supergene enrichment has generally been treated as a continuously progressive process. There is considerable probability, however, that it is essentially cyclic, although the cyclic character may not be patent in all deposits. The essential fact appears to be that as enrichment progresses

and chalcocite increases, the process of enrichment becomes slower in action, and erosion may, in some circumstances, overtake it. With the removal of some of the protecting zone of chalcocite the protore, or original pyritic material, is again exposed to oxidation and a second cycle of enrichment begins. F. L. R.

GEOLOGY.—*Bibliography and index of the publications of the U. S. Geological Survey relating to ground water.* OSCAR E. MEINZER. U. S. Geol. Survey Water-Supply Paper **427**. Pp. 169, map 1. 1918.

Gives a brief historical statement of the work done by the Survey on the subject of ground water and lists 609 papers (in 454 volumes) which contain information on ground water, of which 307 papers (in 171 volumes) relate primarily to this subject. It includes brief abstracts of these papers and a detailed index with respect to ground water topics, and contains a map of the United States showing areas covered by the papers listed. O. E. M.

GEOLOGY.—*The Sunset-Midway Oil Field, California. Part I. Geology and Oil Resources.* R. W. PACK. U. S. Geol. Survey Prof. Paper **116**. Pp. 179, pls. 45, figs. 15. 1920.

The Sunset-Midway oil field lies at the south end of San Joaquin Valley, in Kern County, California. Deposits of asphalt and seeps of oil in this region were known to the earliest settlers, but real development did not begin until 1900. Up to the end of June, 1917, more than 2200 wells had been drilled in the field, and on that date 1840 were producing. Up to 1918 the field had produced more than 2,827,900,000 barrels of oil. The largest well flowed for 18 months, and is said to have produced more than 8,000,000 barrels of oil, with a maximum daily production of 65,000 barrels.

Granitoid and metamorphic rocks form the foundation upon which rest Tertiary and possibly some Cretaceous sediments. Structure is complex; in the mountain regions the rocks are much folded and faulted, but in the outermost foothills along the border of San Joaquin Valley the folds are broad and open and extend from the main range into the valley. It is about these obliquely trending folds that the petroleum has accumulated. The petroleum is thought to have originated in a Miocene diatomaceous shale, and has for the most part migrated and accumulated in the late Tertiary sandy beds that unconformably overlie the shale. Barren beds are found interspersed among the oil-bearing sands. Near the outcrop the oil becomes viscous or tarry and seals the beds more or less completely. In parts of the field where the oil is buried more than 2000 feet a zone of tar-filled sand lies less than 1000 feet below the surface. This zone is believed to mark the place where the upward-moving hydrocarbons have met and been oxidized by surface waters.

The paper includes descriptions of the individual areas with suggestions for future work. J. D. SEARS.

GEOLOGY.—*Geology and water resources of the Gila and San Carlos Valleys in the San Carlos Indian Reservation, Arizona.* A. T. SCHWENNESEN. U. S. Geol. Survey Water-Supply Paper **450**-A. Pp. 27 (1–27), pls. 4, figs. 2. 1919.

Most of the arable land in the valleys of Gila and San Carlos rivers, within the San Carlos Indian Reservation, Arizona, is undeveloped because of the inadequate supply of water for irrigation. The report deals with the physiog-

raphy, geology and water resources of the area, with special reference to the feasibility of drilling for an irrigation water supply in land not included within the proposed San Carlos reservoir. The Reservation includes a plateau area in the northern and eastern parts, and a basin area along Gila and San Carlos rivers. Igneous and pre-Quaternary sedimentary rocks were noted in the mountain areas, and the Quaternary Gila conglomerate in lake beds and river alluvium in the basins.

In 1914, with inadequate dams, the cost of irrigation was $1.34 an acre. Permanent dams are not recommended. The cost of pumped well water would probably be higher, but would be compensated by increased crops. The shallow-well water in the Gila valley is so highly mineralized that it is of doubtful value for irrigation; that in the San Carlos valley is though better but practical experiments should be made. Several structures favorable for artesian supply are described, and a test well is recommended.

J. D. SEARS.

NAVIGATION.—*The prospective utilization of vessel-to-shore radio-compass bearings in aerial and transoceanic navigation.* G. W. LITTLEHALES. Journ. Amer. Soc. Naval Engineers **32**: 38–44. Pl. 1. February, 1920.

A method of finding the latitude and longitude in aerial and marine navigation from vessel-to-station radio-compass bearings is described, and its mathematical theory is expounded. A plate of the construction employed in the practice of the method is given, together with illustrative applications.

G. W. L.

ORNITHOLOGY.—*The birds of North and Middle America.* ROBERT RIDGWAY. U. S. Nat. Mus. Bull. **50**, part 8. Pp. xvi, 852, pls. 34. 1919.

The eighth part of "*The Birds of North and Middle America*" is a systematic treatment of the Charadriiformes, with descriptions and synonymy of genera and species as in the previous portions of this work. The present volume contains the following families, all of which are referred to the order Charadriiformes under three suborders: (1) Limicolae with families Jacanidae, Oedicnemidae, Haematopodidae, Arenariidae, Aphrizidae, Charadriidae, Scolopacidae, Phalaropodidae, and Recurvirostridae; (2) Lari with families Rynchopidae, Sternidae, Laridae, and Stercorariidae; and (3) Alcae with the single family Alcidae. Of these families, the Arenariidae and Sternidae are here elevated from subfamily rank on what are considered sufficient anatomical characters.

Seven genera are here revived in the groups treated: three, *Endomychura* Oberholser, *Ciceronia* Reichenbach, and *Alcella* Stone, are raised from subgeneric rank; and the four others, *Blasipus* Bruch, *Chroicocephalus* Eyton, *Hydrocoloeus* Kaup, and *Mesoscolopax* Sharpe, are wholly additional. One new genus, *Neoglottis*, is instituted, with *Scolopax melanoleuca* Gmelin as type. Four generic groups recognized by some modern authors are considered not separable: *Onychoprion* Wagler, *Melanosterna* Blyth, *Limnocinclus* Gould, and *Leucopolius* Bonaparte.

In this volume 187 species and subspecies are treated. The guillemot known as *Cepphus motzfeldi* (Benicken), often commonly supposed to be an individual variation, is here given full specific rank; and the same treatment is accorded *Uria ringvia* Brünnich. The peculiar sandpiper *Pisobia cooperi* (Baird) is here treated as a good species. The recent Alaskan record of

Pisobia ruficollis (Pallas) is considered valid, and sufficient to warrant the inclusion of the species in the North American list. The Frazar oystercatcher, *Haematopus frazari*, proves to be a subspecies of *Haematopus palliatus*, not, as commonly supposed, a full species. Nearly all the recently separated North and Middle American subspecies of shore-birds are suppressed as insufficiently distinct for recognition. Three new subspecies are herein described: *Pagolla wilsonia beldingi* from La Paz, Lower California; *Pagolla wilsonia cinnamomina* from Sabanilla, Columbia; and *Sterna anaetheta nelsoni* from Sihuatnejo, Guerrero, Mexico. HARRY C. OBERHOLSER.

ORNITHOLOGY.—*Description of a whippoorwill from Porto Rico.* ALEXANDER WETMORE. Proc. Biol. Soc. Wash. **32**: 235–238. December 31, 1919.

A whippoorwill from the island of Porto Rico appears to belong to a new species, and is here named *Setochalcis noctitherus*. It is most closely allied to *Setochalcis vocifera vocifera*, but differs in its shorter wing and certain color characters of the female. Bones of this species have been found in cave deposits on the island of Porto Rico and the species is now probably extinct. HARRY C. OBERHOLSER.

ORNITHOLOGY.—*Description of a new subspecies of Pipilo fuscus.* HARRY C. OBERHOLSER. Condor **21**: 210–211. September 30, 1919.

A series of Towhees from the middle portion of the peninsula of Lower California belongs to an undescribed subspecies which may bear the name *Pipilo fuscus aripolius*. Though occupying a geographic position intermediate between *Pipilo fuscus senicula* of northern Lower California and *Pipilo fuscus albigulus* of the Cape San Lucas region, this new race differs from the latter in its longer tail, and in its darker and more grayish coloration. It is of considerable interest since it establishes direct and complete intergradation between *Pipilo fuscus senicula* and *Pipilo fuscus albigulus*, and shows that these birds are but subspecifically related. This fact makes necessary the reduction of *Pipilo crissalis* and its races to subspecies of *Pipilo fuscus*. H. C. O.

ORNITHOLOGY.—*The bird rookeries of the Tortugas.* PAUL BARTSCH. Smithsonian Report for **1917**: 469–500. Pls. 1–38. 1919.

The small group of keys that compose the Tortugas is situated some 65 miles west of Key West, Florida. These keys are of much ornithological interest since they furnish a breeding place for large numbers of water birds, particularly terns. A census of the birds on these islands taken July 19–31, 1917, shows 32,810 individuals of 19 species present, although only *Sterna fuscata, Anous stolidus stolidus, Sternula antillarum antillarum*, and *Sterna dougalli* breed here. A list of all the birds hitherto found on the islands totals 129. While no land birds nest here this list is of interest as showing that the Tortugas are a good pausing place for north and south bound migrants. The 38 half-tone plates represent chiefly various water birds, their nests, eggs, and young. HARRY C. OBERHOLSER.

ORNITHOLOGY.—*Birds observed on the Florida Keys and the southern end of the mainland of Florida in 1919.* PAUL BARTSCH. Year Book of the Carnegie Institution **18**: 205–210. 1920.

Daily notes on the birds of the Florida Keys and southern Florida are

here presented in chronological order from December 28, 1918, to May 19, 1919. These observations furnish many data on the occurrence of birds in these localities. In all, 97 species and subspecies were observed, of which a list is given and on which notes are recorded. Of particular interest is an immature great white heron taken from a nest on one of the keys and subsequently sent by parcel post to the Zoological Garden at Washington; and a new subspecies of clapper rail from the sixth key southwest of Big Pine Key, to be subsequently described.

HARRY C. OBERHOLSER.

ORNITHOLOGY.—*The systematic position of the ring-necked duck.* N. HOLLISTER. Auk **36:** 460–463. 1919.

A study of the ring-necked duck (*Marila collaris*) in life and in the laboratory indicates that this species is more closely related to *Nyroca americana* than to members of the genus *Marila* with which it is usually associated. It is the New World representative of *Marila fuligula*, and in a sequence of species or in the separation of allied species into generic or subgeneric groups, it should be placed between *Nyroca americana* and *Marila fuligula*.

HARRY C. OBERHOLSER.

ORNITHOLOGY.—*Federal protection of migratory birds.* GEORGE A. LAWYER. U. S. Dept. Agric. Year Book **1918:** 303–316. 1919.

Game birds, particularly waterfowl, have greatly decreased in the United States during recent decades. This condition has induced the various states of the Union to pass numerous laws for the protection of such birds. This has, however, not been sufficient, and a Federal law was enacted in 1913, while in 1916 the Migratory Bird Treaty between the United States and Canada was negotiated. This treaty protects ducks, shore birds, insectivorous birds, and many other migratory species. An enabling act validating this treaty was passed by the Congress of the United States in 1918, by which statute the Secretary of the United States Department of Agriculture is given jurisdiction over the administration of this law, and in him is vested the authority to promulgate regulations for its enforcement. Many states have already conformed their laws to the Federal regulations, and the outlook for the increase of birds under such cooperation is bright.

HARRY C. OBERHOLSER.

ORNITHOLOGY.—*Habits and economic relations of the guano birds of Peru.* ROBERT E. COKER. Proc. U. S. Nat. Mus. **56:** 449–511. Pls. 53–69. 1919.

During the course of investigations on the guano and fishery industries of Peru many opportunities for observing the birds of the guano islands along the coast of that country were offered. The various sea birds of these rocky, barren islands produce annually 20,000 tons of guano, while between 1851 and 1872, 10,000,000 tons were extracted from the Chincha Islands alone. These islands, valuable as they are from a commercial standpoint, are not less interesting scientifically. The most important guano-producing bird of this region is *Phalacrocorax bougainvillei*, not, as commonly supposed, *Sula variegata*, which is much less valuable in this way than either the cormorant or the pelican. Of this species of cormorant there were estimated to be about 150,000 individuals on the Ballestas Islands,

and about 750,000 on the Chincha Islands, 400,000 of the latter being young. The next important producer of guano is *Pelicanus thagus*, of which 100,000 were found on the islands of Lobos de Afuera. Other birds are much less productive of guano, but make, however, some contribution. Among these other birds, those most conspicuous in this region are *Spheniscus humboldti*, *Larus dominicanus*, *Larus belcheri*, *Larus modestus*, *Sterna hirundinacea*, *Larosterna inca*, *Diomedea irrorata*, *Oceanites oceanicus*, *Hydrobates pelagicus*, *Puffinus griseus*, *Pelecanoides garnoti*, *Sula nebouxii*, *Phalacrocorax vigua*, and *Phalacrocorax gaimardi*. The 17 plates show various features of the remarkable avian fauna of these islands. HARRY C. OBERHOLSER.

ORNITHOLOGY.—*Notes on the races of* Quiscalus quiscula (*Linnaeus*). HARRY C. OBERHOLSER. Auk **36**: 549–555. 1919.

Recent investigations show that the three current subspecies of *Quiscalus quiscula* (Linnaeus) are fully entitled to recognition; but since *Quiscalus quiscula quiscula* (Linnaeus) was originally based on the bird from South Carolina, which is the same as the Florida race *Quiscalus quiscula aglaeus* Baird, it becomes the name for the southern race. The northern bird hitherto called *Quiscalus quiscula quiscula* proves to be without a name, since all the synonyms of the species relate to the typical form from the southern United States. The birds from the middle and eastern United States are therefore named *Quiscalus quiscula ridgwayi*. H. C. O.

ORNITHOLOGY.—*Description of another new subspecies of* Lanius ludovicianus. HARRY C. OBERHOLSER. Wilson Bull. **31**: 87–90. 1919.

The breeding form of *Lanius ludovicianus* that occupies north central Lower California is a readily recognizable subspecies, and is here named *Lanius ludovicianus grinnelli*. It is a very darkly colored bird with little white on the scapulars, and small terminal white areas on the outer rectrices, and is apparently most nearly related to *Lanius ludovicianus anthonyi* and to *Lanius ludovicianus mearnsi*. Present investigations show that *Lanius ludovicianus mearnsi* is readily recognizable as a subspecies although commonly considered a synonym of *Lanius ludovicianus anthonyi*.

H. C. O.

ORNITHOLOGY.—*The status of* Larus hyperboreus barrovianus *Ridgway*. HARRY C. OBERHOLSER. Proc. Biol. Soc. Wash. **32**: 173–176. 1919.

A further investigation into the claims of *Larus hyperboreus barrovianus* Ridgway to recognition as a subspecies indicates that it is a tenable race. It is distinguishable from *Larus hyperboreus hyperboreus* in the smaller size; in the relatively as well as actually slenderer bill; and in the noticeably darker upper surface. H. C. O.

ORNITHOLOGY.—*Reports on the scientific results of the expedition to the tropical Pacific in charge of Alexander Agassiz. XXI. The birds.* CHARLES HASKINS TOWNSEND and ALEXANDER WETMORE. Bull. Mus. Comp. Zool. **63**: 151–225. 1919.

This is a report on collections made by Mr. Charles H. Townsend during the cruise of the U. S. Fisheries Steamer "Albatross," in the Pacific Ocean from August, 1899, to March, 1900. During this voyage, which was undertaken for the purpose of studying the coral reef district of the tropical Pacific the following island groups were visited: Marquesas, Paumotu, Society,

Cook, Tonga, Fiji, Ellice, Gilbert, Marshall, Caroline, and Ladrone. There was made a collection comprising 406 specimens of birds, representing 93 forms, 14 of them here described for the first time. An annotated list of the species obtained gives various data on plumage, relationships, and distribution, and includes also various critical notes. The new species and subspecies here described are as follows: *Ixobrychus sinensis moorei*, from Uala Island, Caroline Islands; *Globicera oceanica townsendi* from Ponapé Island, eastern Caroline Islands; *Sauropatis sacra rabulata* from Eua Island; Tonga Islands; *Sauropatis sacra celada* from Vavau Island, Tonga Islands *Myiagra townsendi* from Kambara Island, Fiji Islands; *Conopoderas atypha* from Fakarava Island, Paumotu Islands; *Conopoderas atypha rava* from Whitsunday Island, Paumotu Islands; *Conopoderas atypha crypta* from Makemo Island, Paumoto Islands; *Conopoderas atypha agassizi* from Apataki Island, Paumotu Islands; *Conopoderas atypha nesiarcha* from Rangiroa Island, Paumotu Islands; *Conopoderas atypha erema* from Makatea Island, Paumotu Islands; *Conopoderas percernis* from Eukuhiva Island, Marquesas Islands; *Pinarolestes nesiotes* from Kambara Island, Fiji Islands; and *Wyzomela rubrata* [sic] *dichromata* from Ponapé Island, eastern Caroline Islands.

H. C. OBERHOLSER.

ORNITHOLOGY.—*Notes on North American birds. IX.* HARRY C. OBERHOLSER. Auk **36**: 556–559. 1919.

The proper name for the bird now known as *Phaethon americanus* is *Leptophaethon lepturus catesbyi*, since the American bird is only subspecifically separable from *Leptophaethon lepturus*. The form of *Scaeophaethon rubricaudus* occurring accidentally in North America proves to belong to the subspecies *Scaeophaethon rubricaudus rothschildi* instead of to the typical race as hitherto supposed. The forms of the genus *Casmerodius* (*Herodias*) are commonly considered as distinct species. They are, however, only subspecifically related, as their individual variation clearly shows. Birds from Australia, separated recently as *Herodias alba syrmatophora* Gould by Mr. G. M. Mathews, do not appear to differ sufficiently from *Casmerodiues albus timoriensis* to be maintained as a separate subspecies. The forms of this beautiful heron should, therefore, stand as *Casmerodius albus albus*, *Casmerodius albus timoriensis*, and *Casmerodius albus egretta*. The specimen that forms the basis of the North American record of *Charadrius dubius* Scopoli proves to belong to the recently distinguished race *Charadirus dubius curonicus*. This being the case, it should stand as such on our North American list.

H. C. O.

ORNITHOLOGY.—*A new subspecies of Prunella modularis from the Pyrenees.* FRANCIS HARPER. Proc. Biol. Soc. Wash. **32**: 243–244. 1919.

Several specimens of *Prunella modularis* from the Pyrenees of France represent a new subspecies, which is here called *Prunella modularis mabbotti*. It differs from its nearest ally, *Prunella modularis modularis* in the much more grayish, less rufescent coloration of the back and wings. The type locality is a mountain about three kilometers south of Salliagouse, Department of Pyrenees-Orientales, France.

HARRY C. OBERHOLSER.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

BIOLOGICAL SOCIETY

614TH MEETING

The 614th meeting of the Biological Society of Washington was held October 30, 1920, at 8.10 p.m., in the lecture hall of the Cosmos Club. Vice-president NED HOLLISTER presided, and 41 persons were present.

Brief notes were submitted as follows: DR. T. S. PALMER announced the meeting of the American Ornithological Union in the United States National Museum, November 9–11, with concurrent exhibits in the Library of Congress and National Museum. Dr. L. O. HOWARD stated that during the summer he witnessed a flight of grasshoppers in France. Part of the army was detailed to fight them. In the course of the operations they found the grasshoppers to be a very desirable article of diet.

Regular program

AUSTIN H. CLARK: *On crinoids.*

In the recent seas there are found 576 species, 142 genera, and 28 families of crinoids; 76 species, 22 genera, and 6 families include stalked forms, while 500 species, included in 120 genera and 22 families, are comatulids. The speaker discussed the interrelationships of the crinoids; viviparous crinoids; sexual differentiation; regeneration; asymmetry; the composition of the crinoid skeleton; distribution; the paleontological history of the recent crinoids and their relation to the fossils; the occurrence of the littoral crinoids; the re ation of the crinoids to temperature; food, locomotion and color; and the extraordinary close structural correspondence between crinoids and plants, with the reasons for it. He called attention to the fact that the fixed marine animals are most markedly differentiated by their food-collecting mechanism, while the plants are chiefly differentiated by their flowers; paralleli m in the conditions to be met has resulted in the polyps and the crinoid crowns and the insect-pollinated flowers adopting a similar form and differential value. He also mentioned that the arrangement of the gonads in the crinoids is essentially similar to that of the flowers in wind pollinated plants The paper ended with a discussion of the plant-like relationships existing between the crinoids and the arborescent marine animals and their parasites. (Author's abstract.) The paper was discussed by Dr. L. O. HOWARD and Mr. A. A. DOOLITTLE.

WALTER J. SWINGLE: *Ch nese botany and Chinese botanists.*

Mr. Swingle commented upon the exceeding richness of China's flora, especially that of trees and shrubs. China possesses all but one of the genera of woody plants occurring in the United States, besides many of her own. The causes were traced to the absence of natural barriers to free north and south migration of species during the glacial periods. The number of species in some of the genera, and the importance of many of the species to agriculture, were discussed. Mr. Swingle stated that China had a very ancient botanical literature. Some of the works of great magnitude and value date back for

more than ten centuries, and are more creditable than some recent works in occidental countries. There are still some very active botanists, one of whom has published the largest descriptive treatise ever attempted, and one of great merit. Successful agricultural schools are established, as well as reforesting projects. The paper was illustrated by lantern slides of Chinese plants, plant environments, books, gardens and botanists. The paper was discussed by Mr. T. L. GARY.

615TH MEETING

The 615th meeting of the Biological Society of Washington was held in the lecture hall of the Cosmos Club on November 13, 1920. Vice-president NED HOLLISTER called the meeting to order at 8.10 p.m., with 40 persons present.

On recommendation of the Council Messrs. OSCAR P. SILLIMAN, Salinas, California; M. SLOOG, of the A. L. P. Agence de Libraire de Publications, New York City; S. STILLMAN BERRY, Redlands, California, and HERBERT J. PACK, Logan, Utah, were elected to membership.

Informal communications

Dr. PAUL BARTSCH stated that the ship-worm problem in San Francisco Bay is reaching important proportions. The Navy has lost $7,000,000 worth of piling, and commercial shipping has sustained a loss of $5,000,000. The damage is caused by a *Teredo*, probably undescribed. Dr. Bartsch also referred to two land shells, Epiphragmophora, which have probably been differentiated very recently. One, a large form, was rather rare under the needles of cypress, and at a little distance, occurring only on rocks under shelter; *Mosambrianthum*, a composite, was a small form, otherwise identical. Each had its own associates. Also in the Hawaiian Islands, Dr. Bartsch noted a honey-eating bird with the same repulsive odor as that of the Honey Creeper of South America. An explanation of the similarity of odors was desired.

Dr. T. S. PALMER, referring to the meeting of the American Ornithological Union, recently held in Washington, said that the attendance was 140, out of a membership of 1140, the largest on record. The attendance at the technical sessions indicated great interest. The Chairman remarked, apropos of interest in the more technical aspects of biology, that the symposium upon subspecific characters brought out both large attendance and great interest, when the subject was wholly technical.

Mr. WILLIAM PALMER exhibited the type skull of *Rhabdosteus*, one of several genera of very peculiar dolphin-like animals, possessing extremely extended upper jaws. Mr. Palmer exhibited parts of a similar skull, enough to reconstruct a skull 39 inches long, collected from the beds south of Chesapeake Beach, Maryland.

Regular program

R. W. SHUFELDT: *A snake affected with chiggers.*

A black snake was found by Dr. Shufeldt which had unusual swellings in the skin of the anterior third of the body. The animal could not shed the skin thus affected, and seemed to be considerably discomfited. A little soaking in warm water enabled the skin to be removed easily, and the snake gave evidence of relief. The snake had been in the hands of several biologists, and on coming into the hands of Dr. H. E. EWING, of the Bureau of Entomology, the skin was microscopically examined, and was clearly found

to be harboring a number of chiggers. The pests were confined to the scaly outer membrane. A photograph of the infected snake and microscopic preparations of the skin showing the chiggers were exhibited.

Dr. Shufeldt's paper was discussed by Dr. BARTSCH, who had seen ticks upon a black snake. Mr WM. PALMER had noticed ticks on the Pine Lizard. Mr. GOLDMAN had found ticks common in the ears of snakes and lizards in South America. Dr. EWING, commenting upon the specimen and in answer to questions raised, said that the chiggers were doubtless wholly adventitious upon the snake, and that the instance did not throw any light upon the life history of the chigger, which was unknown, except in the case of a disease-bearing species of Japan. The supposed immunity of individuals to chiggers, their very unequal distribution, even in circumscribed areas, and other problems connected with their life history and economic relations, were discussed. Col. THOMAS CAREY emphasized the need for investigations of this pest.

CHARLES W. GILMORE: *Remarks on some additions to the fossil vertebrate exhibition in the National Museum.*

Dr. Gilmore discussed some of the difficulties involved in building up a representative exhibition collection of fossil vertebrates. It was pointed out that of 20,000 specimens in the National Museum, only 40 were articulated skeletons, or of every 1000 specimens collected, only two might be expected to be perfect enough to be suitable for exhibition purposes. This ratio was not considered a constant one for all collections, but it indicated the comparative rarity of well-preserved fossil vertebrate specimens.

It was shown that the articulation and mounting of fossil skeletons for public exhibition is a comparatively recent phase in the development of vertebrate paleontology in this country. Very few were thus exhibited prior to 1900, and the first skeleton in the National Museum was set up in 1902.

The great amount of time consumed in prepairng fossil skeletons for exhibition was discussed. A skeleton of *Dimetrodon* required 533 working days, and that of *Stegosaurus* 626 days, or more than two years' steady work for one man. The style of mounts was briefly touched upon, and the desirability of preserving articulated skeletons, especially of the reptiles, in the positions in which they were found in the field, was emphasized.

The National Museum was said to rank third on the list among American museums having similar exhibits of extinct vertebrate life.

Following this brief discussion Dr. Gilmore exhibited slides of the more important accessions to the collection in recent years. The most striking of these were: *Stegosaurus*, an armored dinosaur; *Ceratosaurus*, a flesh-eating dinosaur; *Dimetrodon*, a giant spined reptile; *Brontotherium*, a large mammal from Nebraska; *Epigaeilus*, a horned rodent from Kansas; *Stenomylus*, a small camel from Nebraska. The more striking characteristics of these animals were pointed out and life restorations were shown, including two modeled by the speaker and here exhibited for the first time. (Author's abstract.)

The paper was discussed by Drs. T. S. PALMER, SHUFELDT, and BARTSCH.

A. A. DOOLITTLE, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

The National Geographic Society announces the foundation of a series of Memoirs for the publication of the results of its expeditions. The first number will be devoted to a general account of the Katmai Expeditions, and technical papers on the botanical, entomological, geological and chemical results will follow. Prof. R. F. GRIGGS, director of the Katmai Expeditions, has been requested to devote his full time to the completion of this series of reports, and has accordingly resigned from the faculty of the Ohio State University and has taken up his residence in Washington.

At the request of the Radio Dynamic Torpedo Unit, Coast Artillery Corps, U. S. Army, arrangements have been made for the cooperation of the Coast and Geodetic Survey with the U. S. Army in the securing of data on currents in connection with the development of subaqueous sound ranging.

The Secretary of State has authorized Mr. WILLIAM BOWIE, who, prior to the war, was a member of the Permanent Commission of the International Geodetic Association, to notify the secretary of the Neutral Geodetic Association that the United States formally withdraws from this association. In 1916, a number of neutral countries—the United States being one of them—voted to continue the International Geodetic Association. When the United States entered the war it ceased to take an active part in this association.

Within the two years of its existence the new Czecho-Slovak Republic has established two new universities, one at Brno (Brunn) and the other at Bratislava (Pressburg). In addition the University at Prag finds itself this year with a nearly redoubled number of students, of whom there are now over 10,000. With the generally and greatly reduced exchange values of European currency, it has become exceedingly difficult for the scientific men of these universities to provide themselves with literature in all branches of learning published since 1914, and they appeal to their American colleagues for all possible help in this direction. Publications should be sent to Dr. A. HRDLICKA, U. S. National Museum.

The Division of Plants of the National Museum has received a package of plants from the State of Oaxaca, Mexico, collected by Professor C. CONZATTI, who has from time to time during the last twenty years forwarded to the Museum several thousand Mexican plants. Most notable among the specimens of this last shipment is a branch from the famous cypress tree at El Tule, near the city of Oaxaca. This tree, which is many centuries old, has a trunk circumference of over 100 feet and a height of about 130 feet, and is one of the largest trees known.

A valuable and well-mounted collection of moths and butterflies, including many from Oriental countries, collected by the late J. P. IDDINGS, petrologist and mineralogist, has been presented by his heirs to the National Museum.

Dr. GEORGE I. ADAMS, formerly with the U. S. Geological Survey, spent October in Washington. Since leaving the Survey he has been professor of geology in the Government University at Peking, China, and is now pro-

fessor of geology and mineralogy in the University of Alabama, at Tuscaloosa, Alabama.

Dr. H. FOSTER BAIN, consulting geologist and mining engineer, and formerly editor of the *Mining and Scientific Press* and the *Mining Magazine*, has been nominated as Director of the Bureau of Mines, Department of the Interior, to succeed Dr. F. G. COTTRELL, who resigned on January 1 in order to devote full time to his work as Chairman of the Division of Chemistry and Chemical Technology, National Research Council.

Dr. HENRY ANDREWS BUMSTEAD, professor of physics and director of the Sloane Physical Laboratory, Yale University, and chairman of the National Research Council in Washington, died on January 1, 1921, while on his way to Washington from the Chicago meeting of the American Association. Dr. Bumstead was born at Pekin, Illinois, March 12, 1870. He had been connected with the department of physics at Yale since his graduation from Johns Hopkins University in 1891. His research work had been chiefly in the fields of radioactivity and Röntgen radiation. During the war he was scientific attaché to the American Embassy in London.

Dr. M. E. HOLMES has been appointed manager of the chemical department of the National Lime Association, with offices at 918 G Street, Washington.

Mr. B. L. JOHNSON has been placed in charge of the Section of Foreign Mineral Reserves of the U. S. Geological Survey.

Mr. FREDERICK H. NEWELL, formerly Chief of the U. S. Reclamation Service, who in 1915 became professor of civil engineering at the University of Illinois, has withdrawn from his university work and is again making his headquarters in Washington.

The party under E. W. SHAW, including G. L. HARRINGTON, EDWIN KIRK, and C. P. ROSS, geologists, and R. H. SARGENT, topographer, which for nine months has been making geologic and topographic surveys in South America, has returned to this country. Mr. Shaw resumed his regular work on the Geological Survey in January.

Prof. C. J. TILDEN, professor of engineering mechanics at Yale University, has been granted leave of absence for a year to accept the position of director of the highway and highway transport education committee, of which Dr. P. P. CLAXTON, U. S. Commissioner of Education, is chairman. The new director will take charge immediately of the work planned by the committee, which includes the compilation of economic, scientific, and engineering data relative to highway construction and highway transport, and the distribution of these data to educational institutions.